

In Claim 16 at p. 28, line 15, please delete "recirculating".

A² 22. (Amended) The method of Claim 1 wherein the first [recirculating] refrigeration system [circuit] and the second [recirculating] refrigeration system [circuit] provide in a single heat exchanger a portion of the total refrigeration required to liquefy the feed gas.

REMARKS

Reconsideration is requested for the rejection of Claims 1-26 in view of the amendment presented above and the Remarks which follow.

Claims 6 and 16 have been amended in response to the Examiner's rejection for being indefinite under 35 USC 112, second paragraph. Claim 22 has been amended to correct errors in antecedence which were noticed by Applicants after the application was filed.

Rejections Under 35 USC 112

Claims 6, 16-21, 25, and 26 have been rejected as indefinite under 35 USC 112, second paragraph. Claims 6 and 16 have been amended to correct the indefinite language regarding the second refrigeration system by deleting the incorrect antecedent basis for the term "recirculating". In view of this amendment, it is requested that the rejection of Claims 6, 16-21, 25, and 26 under 35 USC 112, second paragraph be withdrawn.

Rejections Under 35 USC 103(a)1) Claims 1-5, 7-12, and 22

Claims 1-5, 7-12, and 22 have been rejected under 35 USC 103(a) as unpatentable over U.S. Patent 3,763,658 to L. S. Gaumer et al ("Gaumer") in view of U.S. Patent 4,970,867 to D. M. Herron et al ("Herron").

Gaumer discloses a natural gas liquefaction process in which a single component refrigerant is utilized in a first recirculating refrigeration system to precool the feed gas. This single component refrigerant also is used to cool and liquefy a mixed refrigerant stream in a second recirculating refrigeration system which provides refrigeration at a lower temperature for final liquefaction of the natural gas. In both of these refrigeration systems, the refrigerants are condensed at higher pressures, reduced in pressure by throttling valves, and evaporated at lower pressures to provide the necessary refrigeration.

Herron discloses a natural gas liquefaction process in which final liquefaction is effected by mixed refrigerant streams in a recirculating refrigeration system. Mixed refrigerant vapor is compressed, partially condensed, and separated into liquid and vapor refrigerant streams. The vapor stream is further compressed, liquefied, reduced in pressure by work expansion in a turboexpander, and vaporized to provide refrigeration. The work generated by expansion is utilized for the compression of the vapor. The liquid stream is pumped to a higher pressure, subcooled, reduced in pressure by work expansion in a turboexpander, and vaporized to provide additional refrigeration. The work generated by expansion is utilized for pumping the liquid.

The claimed invention is a method for liquefying a feed gas in which at least a portion of the total refrigeration required to cool and condense the feed gas is

provided by a first refrigeration system comprising at least one recirculating refrigeration circuit, wherein the first refrigeration system utilizes two or more refrigerant components and provides refrigeration in a first temperature range. An additional portion of the refrigeration is provided by a second refrigeration system which provides refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream.

The prior art as defined by Gaumer and Herron differs from the claimed invention in an important and fundamental way. Both Gaumer and Herron provide all refrigeration by reducing the pressure of liquefied refrigerants and vaporizing the reduced-pressure liquids. Gaumer teaches that liquid refrigerants are reduced in pressure across throttling valves 66, 74, 80, 92, 94, 116, and 128 as described in the Figure (see column 3, lines 46-48, 56-59, and 65-67; column 4, lines 26-29 and 35-37; column 5, lines 64-66; and column 6, lines 14-15). Herron teaches that liquid refrigerants 26 and 38 of the Figure are reduced in pressure across turboexpanders 141 and 151 (see column 5, lines 9-13 and 24-26).

In contrast to the above prior art teachings, the claimed invention provides refrigeration by a combination of refrigeration from the work expansion of a gaseous refrigerant stream and refrigeration from a multicomponent refrigeration system. The use of a multicomponent refrigeration system in combination with gas expansion refrigeration is described in the specification at p. 16, line 3 to p. 17, line 7 and in Figs. 1-9. The claimed invention includes the work expansion of a gaseous refrigerant stream while Herron teaches the work expansion of a liquid refrigerant stream.

The person skilled in the gas liquefaction art would find no teaching or suggestion in the Gaumer and Herron patents that refrigeration generated by gas expansion can be used in a gas liquefaction process. Gaumer and Herron are

completely silent regarding gas expander refrigeration systems, and for this reason the skilled person would not derive therefrom the use of gas expander refrigeration in a gas liquefaction process. The skilled person who combined the teachings of Gaumer and Herron would arrive at a liquefaction process in which all refrigeration would be provided by reducing the pressure of liquefied refrigerants and vaporizing the reduced-pressure liquids, and this liquefaction process would not use gas expander refrigeration.

Because of these differences between the claimed invention and the teachings of Gaumer and Herron, and the interpretation of these teachings by the skilled person, Applicants respectfully submit that the Examiner has not established obviousness under 35 USC 103(a) in rejecting the claimed invention over Gaumer taken with Herron. It is requested that the rejection of Claims 1-5, 7-12, and 22 under 35 USC 103(a) over Gaumer and Herron be withdrawn.

2) Claims 12-15

Claims 12-15 have been rejected as unpatentable over Gaumer in view of Herron as applied to Claims 1-5, 7-12, and 22, and further in view of U.S. Patent 4,755,200 to Y. N. Liu et al ("Liu").

Liu discloses a natural gas liquefaction process in which a single component refrigerant is utilized in a first recirculating refrigeration system to precool the feed gas. This single component refrigerant also is used to cool and liquefy a mixed refrigerant stream in a second recirculating refrigeration system which provides cooling at a lower temperature to a refrigerant in a third recirculating refrigeration system. The third refrigerant system provides cooling for final liquefaction of the natural gas. In all three of these refrigeration systems, the refrigerants are

condensed at higher pressures, reduced in pressure by throttling valves, and evaporated at lower pressures to provide the necessary refrigeration.

The disclosures of Gaumer and Herron are described above. A statement of the claimed invention also is given above.

The prior art as defined by Gaumer, Herron, and Liu differs from the claimed invention in an important and fundamental way. Gaumer, Herron, and Liu provide all refrigeration by reducing the pressure of liquefied refrigerants and vaporizing the reduced-pressure liquids. Gaumer teaches that liquid refrigerants are reduced in pressure across throttling valves 66, 74, 80, 92, 94, 116, and 128 as described in the Figure (see column 3, lines 46-48, 56-59, and 65-67; column 4, lines 26-29 and 35-37; column 5, lines 64-66; and column 6, lines 14-15. Herron teaches that liquid refrigerants 26 and 38 of the Figure are reduced in pressure across turboexpanders 141 and 151 (see column 5, lines 9-13 and 24-26). Liu teaches that liquid refrigerant streams are reduced in pressure across throttling valves 66, 70, 84, 117, 122, and non-numbered throttling valves adjacent to valve 122 and adjacent to main exchanger 14 in Fig. 2. This is set forth at column 8, lines 42-44 and 60-68; column 9, lines 11-14; column 5, lines 1-24 and 59-65; and column 6, lines 7-8, 19-22, 29-31, and 38-41.


In contrast to the above prior art teachings, the claimed invention provides refrigeration by a combination of refrigeration from the work expansion of a gaseous refrigerant stream and refrigeration from a multicomponent refrigeration system. The use of a multicomponent refrigeration system in combination with gas expansion refrigeration is described in the specification at p. 16, line 3 to p. 17, line 7 and in Figs. 1-9. The claimed invention includes the work expansion of a gaseous refrigerant stream while Herron teaches the work expansion of a liquid refrigerant stream.

The person skilled in the gas liquefaction art would find no teaching or suggestion in the Gaumer, Herron, and Liu patents that refrigeration generated by gas expansion can be used in a gas liquefaction process. Gaumer, Herron, and Liu are completely silent regarding gas expander refrigeration systems, and for this reason the skilled person would not derive therefrom the use of gas expander refrigeration in a gas liquefaction process. The skilled person who combined the teachings of Gaumer, Herron, and Liu would arrive at a liquefaction process in which all refrigeration would be provided by reducing the pressure of liquefied refrigerants and vaporizing the reduced-pressure liquids without the use of gas expander refrigeration.

Because of these differences between the claimed invention and the teachings of Gaumer, Herron, and Liu, and the interpretation of these teachings by the skilled person, Applicants respectfully submit that the Examiner has not established obviousness under 35 USC 103(a) in rejecting the claimed invention over Gaumer taken with Herron and Liu. It is requested that the rejection of Claims 1-5, 7-12, and 22 under 35 USC 103(a) over Gaumer and Herron be withdrawn.

Allowable Subject Matter

The Examiner has advised that Claims 6, 6-16, and 23-26 would be allowable if rewritten to overcome the rejections under 35 USC 112, second paragraph. The required amendments have been submitted as described above, and therefore these claims are now allowable.

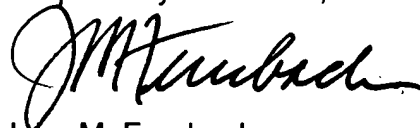


Summary

In view of the amendments and remarks presented above, the Examiner is respectfully requested to withdraw the rejections of Claims 6, 6-16, and 23-26 under 35 USC 112, second paragraph, and the rejections of Claims 1-5, 7-15, and 22 under 35 USC 103(a). A timely Notice of Allowance for Claims 1-26 is anticipated.

The prior art made of record and not relied upon is acknowledged.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "JMFernbacher", is written over the typed name.

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